DESCRIPTION

OF A

PNEUMATIC APPARATUS,

WITH

DIRECTIONS

FOR PROCURING

The Factitious Airs.

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THE SECOND EDITION.

Birmingham,
PRINTED BY THOMAS PEARSON.

MDCCXCV.

SINCE the first publication of this Description, experience has suggested some improvements in the mode of constructing and of using the Apparatus, which in the present state of Pneumatic Medicine, it would be improper to delay communicating to the Public. Every hint, however trifling in itself, now attention is awake, may lead to useful discoveries.

The Author has also availed himself of this opportunity to methodize and elucidate his description in a manner which the former hasty publication would not admit of. One of the original plates has been rejected, and another representing the improved use of the Fire-tubes, has been inserted in its place. Conceiving the Apparatus may fall into the hands of persons who have not been accustomed to chemical experiments, clearness has been aimed at, even at the hazard of

prolixity. Though the Author wiſhes to ſhun the imputation of neologiſm, yet to avoid circumlocutions, he has found himſelf obliged to form ſome new words, ſuch as the Martial, Zincic, *and* Carbonic Inflammable Airs, *which latter he has alſo called* Hydro Carbonate. *He has indifferently made uſe of the terms of the old and new Chemical Nomenclature, wiſhing merely to be underſtood, and not intending to enter into diſcuſſions upon theories in a treatiſe, the objects of which are facts.*

The purchaſers of the firſt edition, it is hoped, will not deem any apology neceſſary. It contained all the Author then *thought worthy the notice of the Public, as this contains all he* now *deems eſſential to the right uſe of the Apparatus, which probably from the progreſſive advancement of Pneumatic Chemiſtry, will ſoon receive great additions.*

At the time of the former publication, few profeſſional men having conſidered the ſubject, the Author

Author ventured to give his opinion in ſome letters to Dr. Beddoes, on the airs which he thought the moſt likely to be of uſe in diſeaſes of the lungs, and he eſteemed it a duty to relate the few phyſiological obſervations he had made in the courſe of his chemical experiments to produce the airs; but he now thinks it would be improper to ſwell his pamphlet by a republication of thoſe letters, as the ſubject is taken up by perſons who are better able to judge in ſuch matters. For what has yet been done in the application of the air to medicinal purpoſes, the Reader is referred to the publications of Dr. Beddoes and Dr. Ewart upon this ſubject.

Several of the apparatus are now in the hands of able practitioners, and the public at large is appriſed of the importance of the ſubject, and will no doubt give it a fair trial. It is honourable to the preſent improved ſtate of ſcience, and it is honourable to the faculty in particular, that the application of Pneumatic Chemiſtry to medicine, far from meeting with that perſecution which

which has generally in every age followed new opinions, has obtained the well wiſhes and liberal ſupport, even of thoſe who have doubts of its efficacy, but who are no leſs deſirous of having thoſe doubts cleared up by actual experiment.

HEATHFIELD, JANUARY 1, 1795.

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DESCRIPTION

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OF A

PNEUMATIC APPARATUS.

THE apparatus may, for the facility of deſcription, be divided into four parts, the uſes of which are eſſentially different. Firſt, an ALEMBIC or POT A, *ſee plate* 1, *fig.* 1, or in lieu of it, a FIRE-TUBE, *a*, (*ſee plate* 1, *fig.* 3, *and plate* 3, *fig.* 1, 2, *and* 3) intended to contain the material or ſubſtance to be expoſed to the action of the heat, with a *Water-pipe* D C, adjuſted to its capital, for the purpoſe of admitting water to aſſiſt the generation or expulſion of the factitious air. Secondly, A REFRIGERATORY G (*plate* 1, *fig.* 1) ſerving to cool and waſh the airs, which are conveyed thither by the *Conducting-pipe* F, connected with the Capital of the Alembic or Fire-tube. Thirdly, an HYDRAULIC BELLOWS H J, to receive and meaſure the air as it comes cooled from the Refrigeratory through the *Communicating-pipe* P. And, fourthly, AN AIR-HOLDER Y, *plate* 3,

fig.

fig. 1 *and* 2, into which the Hydraulic Bellows diſcharge the factitious air by means of the *Transfer-pipe g*, and in which it is afterwards preſerved, and may be removed from one place to another.

In lieu of this latter veſſel, in caſes where the patient is at hand, the air may be immediately transferred from the Hydraulic Bellows through the *Diſcharging-pipe* Q into *oiled ſilk or linen bags*, or ſuch other veſſels as ſhall be thought convenient for mixing it with the proper portion of common air, and alſo for the patient to inhale from.

1. The ALEMBIC and FIRE-TUBE. *The Alembic* A, *ſee plate* 2, *fig.* 4, is made of ſoft caſt iron, about half an inch in thickneſs, and ſix inches in diameter in its wideſt part or *bilge*. It has a Capital B, of the ſame metal, the lower part of which is made conical and ground into its mouth, ſo that the joint may be made tight with a ſmall quantity of cement. Through the middle of the upper part of the Capital, paſſes the *Water-pipe* D C, which reaches to within a ſmall diſtance of the bottom of the Alembic; at the top of it is a cup D to contain water, in the centre of which a wire E is placed, extending within the Water-pipe to C, where it terminates in an acute cone, accurately fitted to the lower opening of the Pipe, as ſhewn in

in *plate* 2, *fig.* 5. The upper end of this wire has a button affixed to it to turn by hand, and the part immediately under it is formed into a ſcrew, which works in a bridge fixed acroſs the cup, ſo that by turning the ſcrew, you may either raiſe or depreſs the wire, and thereby regulate the quantity of water to be admitted, or entirely exclude it. The joints of the Water-pipe at C, and at the top of the Capital, are made conical for the greater facility of rendering them tight, by anointing them with a ſmall quantity of the china clay or other lute hereafter deſcribed, which is likewiſe to be applied to the joint where the *Conducting-pipe* F enters the ſide branch of the Capital.

The alembic above deſcribed, may be uſed for producing any of the artificial airs, and ſeems the beſt veſſel for making that from Zinc. At the time this deſcription was firſt publiſhed, it was thought that it would have proved the moſt convenient for all purpoſes, but experience has ſince ſhewn the contrary.

The *Fire-tube*, ſuch as repreſented in plate 1, fig. 3, when of equal contents with the Alembic, expoſes a greater ſurface to the action of the fire, and diſpoſes the ſubſtances contained in it better to

the operation of the ſteam produced from the water, and thus yields the airs more readily and with leſs waſte of fuel. It is therefore preferable for preparing air from charcoal, iron turnings, chalk, &c. and anſwers very well for the Oxygene air from Manganeſe.

The main tube *a*, *plate* 3, *fig.* 1, 2, *and* 3, is of caſt iron, open at both ends; a kneed pipe, called an *End-piece*, *b*, is afterwards fitted to one extremity, and receives into its perpendicular part a water pipe, ſuch as that deſcribed for the Alembic. To the oppoſite extremity of the tube, another ſimilar end-piece, *c*, is fitted, the ſide branch of which is placed horizontally to receive the Conducting-pipe F, which conveys the air to the refrigeratory. The joints are made conical, ground into one another, and made tight with lute in the ſame manner as thoſe of the Alembic.

The caſt iron of which the Alembics and Fire-tubes, with their Capitals and End-pieces, are made, is certainly liable to ſome objections; but it has been preferred as being the only *ſubſtance* yet tried which can bear the viciſſitudes of heating and cooling,

cooling, and the application of water, when red hot, without much injury, and the only *metal*, not too coſtly, the fumes or abraſions of which produced by the action of the water and airs might not have deleterious effects. For this latter reaſon no copper is employed in any part of the apparatus.

The *Conducting-pipe* F, which conveys the air from the Alembic or Fire-tube to the Refrigeratory, is made of forged-iron, about $1\frac{1}{4}$ inch in diameter, tapering at the ends to fit better. The length is from three to ſix feet, as ſuits the conveniency of the operator. To aſcertain the nature of the air, a ſmall hole, ſtopped with an iron plug, is made near the refrigeratory end; by taking out the plug, and holding a lighted candle to the hole, you may in ſome degree determine when any particular kind of air begins to come over. It would make the apparatus ſtill more perfect, if a bent tube were fitted to the Conducting-pipe near this place, and the air was received according to Dr. Prieſtley's method, in jars through water; but care muſt be taken that the pillar of water through which the air paſſes, be not greater than that in the Refrigeratory. The quality of the air might then be more accurately determined by the uſual teſts.

2. The Refrigeratory. This veſſel is made in three different ways, according to the nature of the airs to be cooled by it.

The *Circulating Refrigeratory* G, *plate* 1, *fig.* 1, is uſed for airs which require waſhing as well as cooling, to make them depoſit any extraneous matters which they would otherwiſe carry over with them. It conſiſts of two parts, as ſhewn in the plans and ſections, *plate* 2, *fig.* 2 *and* 3, the upper part is repreſented in the inverted poſition in which it is to be placed within the other. In *fig.* 2, the outer veſſel G is repreſented, furniſhed at one ſide with a funnel and pipe R, for conveying cold water to the bottom; on the oppoſite ſide are two circular apertures, with ſhort pipes and corks fitted to them; the upper ſerves to let off the heated water, and the lower to empty the veſſel. *Fig.* 3. is a plan and ſection of the inner veſſel S; it is open at bottom, but its cover is convex, and has a ſpiral channel winding along the underſide, which being likewiſe open below, the air coming from the Alembic or Fire-tube by the pipe N, at the circumference, paſſes through the whole of it in conſtant contact with the water of the Refrigeratory, until it arrives at the pipe O, fixed near the centre, which delivers it to the Hydraulic Bellows, by means of the Communicating-pipe P. In this long circuit it is both

both cooled, and in a conſiderable degree waſhed and freed from any matters for which water has an attraction. In the centre of the inner or ſpiral veſſel, is a ſhort pipe open at both ends, reaching to the lower edge of the plates that form the ſpiral, and intended to ſerve as a paſſage for the hot water to riſe through by its leſſer ſpecific gravity, when cold water is introduced below by means of the funnel R, and alſo for the ſtem of the Agitator to work in. The hot water is then ſuffered to run off through the upper pipe of the outer veſſel, and thus by a frequent renewal, the water in the Refrigeratory is kept both cool and unſaturated. A notch is made in the inner veſſel at T, to receive the pipe R, and prevent its impeding the rim of that veſſel from reſting upon the bottom of the other; in which poſition, when in uſe, it is to be kept ſteady by laying lead weights upon it.

When it is wanted to free the airs more perfectly from any acid taint, the *Agitator* or *Stirrer* is to be employed. This inſtrument is made of wood, in form of an inverted T, with a ſmall winch to turn it by at the upper end of the axis or ſtem. The lower end of the axis or ſtem fits into a ſmall cup at the bottom of the Refrigeratory, and the other paſſes through the ſhort pipe in the centre of the inner veſſel, and turns in a ſocket affixed to the

pipe O. The agitator being gently turned round by the winch, puts the whole water in motion; thus continually expoſing freſh ſurfaces to the air in its paſſage to the bellows, and when the water is mixed with the powder of quick lime, it ſerves to keep it ſuſpended.

Tin plates japanned have been found to be the beſt material for making both the inner and outer veſſel.

The *Cloſe Refrigeratory* may be uſed for airs which are liable to be abſorbed by the contact of water, ſuch as fixed or carbonic acid air. It conſiſts of a cylindrical veſſel, with a cloſe diaphragm fixed a few inches from its bottom, as repreſented at X, *plate* 3, *fig.* 1 and 2. The conducting-pipe from the alembic opens into the ſpace below the diaphragm, where the ſteam it brings with it is condenſed, and the air cooled by means of cold water poured into the upper part of the veſſel upon the diaphragm, which is to be renewed as it warms, by letting off the heated water through a pipe *b* made for that purpoſe, and pouring on freſh. By this means the air is compleatly cooled, without coming in contact with the water, and is afterwards conveyed to the hydraulic bellows through the communicating pipe P. An aperture with a ſhort

pipe

pipe *i* is left in the lower or close part of the vessel, to let off the condensed steam, and inspect the quality of the air, if at any time need be.

Should however the circulating refrigeratory be preferred for the sake of washing the air, and freeing it from some of the calcareous earth, or other extraneous matter it brings over with it, the loss of air by the absorption of the water will not be very considerable, for the water soon becomes saturated, and as it grows warm yields back great part of the air in a purer form.

The *Pipe Refrigeratory* is the most simple of all, but can only be used when the air produced brings no aqueous vapours over with it, and requires no washing. Its use is therefore confined to the cooling of *dry* airs, such as that produced from charcoal burning in the open air. It consists of a plain pipe *n* passing longitudinally through a trough *m* filled with water, such as that delineated *plate* 3, *fig.* 5, and connecting the hydraulic bellows immediately with the furnace or pot *l*, in which the charcoal is burning.

By connecting this pipe with any close vessel, to collect the condensed water, it may be made to answer all the purposes of the close refrigeratory.

3. The

3. The Hydraulic Bellows. An outside view of this veſſel is given in H J, *plate* 1, *fig.* 1, and *pl.* 3, *fig.* 1, and an inſide view in *plate* 2, *fig.* 1. It conſiſts of an outer or fixed veſſel H, and an inner or moveable veſſel J, which moves eaſily up and down within the other, and is ſuſpended by a cord paſſing over two pullies K K, and ſuſtaining a counterpoiſe L. To avoid the incumbrance of a great weight of water, the outer veſſel H is made double, ſo that only an interſtice of about half an inch is left between its two cylinders for the veſſel J to move up and down in, and this muſt be filled with water as high as the pricked line in *plate* 2, *fig.* 1. The cup or rim W is to prevent the water from overflowing when the inner veſſel is preſſed forcibly down. The factitious air enters from the refrigeratory by the communicating pipe P, and paſſes along the perpendicular pipe V into the cavity of the veſſel J, which continues riſing until it is full, when the framing M will permit it to go no higher. The air is then expelled into the air-holder or bag, through the *diſcharging-pipe* Q, by lifting up the counterpoiſe L, and allowing the inner veſſel to deſcend by its own weight.

This veſſel is alſo made of tin plate japanned. Some ſlight variations have been made in the execution of thoſe for ſale ſince the two firſt plates were

were engraved, but none of ſufficient importance to merit particular mention.

4. The Air-Holder. The ſtructure of this veſſel is ſhewn at Y, *plate* 3, *fig.* 1 and 2. It is made of tin plate, japanned both inſide and outſide, and is cloſe at both ends; but for the conveniency of japanning the inſide, it is made in two halves, which are joined together in the middle of the veſſel, by a cement compoſed of bee's-wax and one fourth of its weight of roſin, applied hot. By warming the joint before a fire, the veſſel may at any time be taken aſunder, and cleaned. Two ſhort pipes, U and Z, proceed from the ſide of the veſſel, near its top and bottom, and another pipe, *t*, paſſes through the middle of the top or cover, to which it is well ſoldered, and reaches to within half an inch of the bottom.

When the lower pipe Z is corked, the upper one U remaining open, the veſſel may be filled with water through the central pipe *t*, to which, for the conveniency of pouring, a funnel *k* is fitted; by withdrawing the cork of the pipe Z, the water may again be diſcharged, the external air which enters through the pipe U ſupplying its place. So that if when it is filled with water, a ſhort pipe *g*, called the *Transfer-pipe*, be inſerted and cemented into

into the upper pipe U of the air-holder, and into the diſcharging-pipe Q of the hydraulic-bellows, and if the lower pipe Z of the air-holder be then opened, and the inner cylinder of the bellows be allowed to deſcend, by lifting the counterpoiſe, it is obvious that the factitious air contained in it will be transferred into the air-holder. The pipes Z and *t* are to be well corked as ſoon as the air-holder is filled, but there ſhould always be left an inch of water at the bottom of it, to impede ſtill more all communication with the external air; as ſoon as it is disjointed from the reſt of the apparatus, the pipe U ſhould likewiſe be carefully corked*.

Oiled Silk Bags, as it has been already mentioned, are convenient for removing factitious air from one room to another, and for the patient to inhale from. They may be made in the form of a common ſack, tapering at one end like a bottle, and having a conical wooden faucet fixed in the mouth, with the ſmaller end outwards, into which a ſpiggot is to be inſerted.

* Corks are preferred to cocks for ſhutting theſe openings, both becauſe when good, and well fitted, they are perfectly air-tight, and becauſe common cocks are made of a metal, the ruſt of which is very poiſonous, being a compoſition of copper, lead, tin, arſenic, and antimony, or whatever other metals the ores may happen to contain.

To

To free oiled ſilk from its diſagreeable ſmell, cut it into pieces of the ſize wanted for the bags, and provide a ſmooth table ſomewhat larger than the pieces of ſilk, and a flat board of the ſame ſize as the table. Take charcoal *freſh burnt in an open fire* until it is free from ſmoke, extinguiſh it by ſhutting it up in a clean cloſe veſſel, and reduce it to powder. Sift this powder over the table to the thickneſs of a quarter of an inch or more, ſpread a piece of your ſilk upon it, and ſift upon that again another layer of your charcoal duſt, and thus proceed alternating the layers of ſilk and charcoal, until the whole of your ſilk is depoſited; then lay your moveable board upon the top of all, and leave the whole undiſturbed for four or five days. If upon removing the charcoal duſt, the ſilk has not loſt its ſmell entirely, repeat the proceſs. The charcoal duſt is to be ſwept off the ſilk, and the ſilk to be waſhed upon a table with a wet ſponge until it is clean. The bags muſt then be carefully ſowed up, and the ſeams anointed with japanners' gold ſize, taking care to uſe that kind which does not become brittle when dry. This is uſed in preference to drying oil, becauſe it has not ſo bad a ſmell. Green oiled ſilk ſhould be avoided, as it is ſtained by means of verdigris, which rots it; the yellowiſh ſilk is the beſt.

Dr.

Dr. Beddoes obſerves, that the thicker oiled ſilk anſwers better than the thinner kind; that perhaps oiled linen may be found to anſwer; that the bags, when out of uſe, ſhould be hung up by a ſtring tied to the faucet, and that they ſhould be as little creaſed as poſſible. To this it may be added, that the beſt way of emptying them of all the air they contain, is to lay them flat upon a table, and to paſs the hand, or a round paper ruler, gently over them.

It is neceſſary to obſerve here, that although oiled ſilk be the beſt ſubſtance known for making the bags of, it is very imperfectly air-tight; and although charcoal duſt deprives it of ſmell for the time, yet as it can only attract the odoriferous particles from the ſurface, it re-acquires ſome ſmell by keeping, but by no means equal to what it had at firſt.—The deſideratum is ſome thin flexible ſubſtance, whoſe pores can be more perfectly cloſed than thoſe of ſilk, and a varniſh without ſmell, or ſome kind of light bellows, not of the hydraulic kind.

Furnace. Many perſons to whom this apparatus will be uſeful, being unprovided with a convenient furnace, I have endeavoured to make one of ſuch a conſtruction as to adapt it to the uſes both of the alembic and fire-tube, which has neceſſitated

ſitated ſome ſlight variations from the one repreſented *plate* 1, *fig.* 1, but which are all ſhewn in *plate* 3, *fig.* 1, 2, 3.

The aſh-pit and furnace are both made of one piece, of a cylindrical form. The furnace part is lined with fire bricks, is 14 inches diameter within, and 18 inches over all; the depth to the grate is 11 inches, and that of the aſh-pit about 7. Two circular holes, of $4\frac{1}{2}$ inches diameter, are made in two oppoſite ſides of the furnace to admit the fire-tube, which when the alembic is uſed, are to be ſtopped with plugs of fire clay. Two caſt iron rings, *r r*, are ſent with the fire-tubes, which when they are uſed fit upon the ends, and ſerve to ſhut up the circular holes of the furnace as accurately as can be done. The covers drawn in *plate* 1 are not found to be neceſſary.

A *ſmaller* furnace has likewiſe been made for a ſmaller apparatus, 9 inches diameter within the brick lining, and 9 inches deep to the grate. The fire-tubes for this are only 3 inches diameter without.

Thoſe who wiſh occaſionally to convert theſe furnaces into diſtilling furnaces, may have a fire-door *d* fitted to one of the ſide holes, a chimney-

pipe

pipe *p* to the other, and a caſt iron pot for containing ſand, adapted to the mouth of the furnace; *ſee plate* 3, *fig.* 4; but none of theſe are neceſſary for the particular application of it to this apparatus.

Both furnaces have a door *f* to ſhut up the aſh-pit, and at one ſide a ſliding damper *s*, to regulate the quantity of air admitted, for when the coaks are good, and the grate clear from aſhes, the fire might become too ſtrong if the fire door were to be left open. No chimney is uſed in the operations for producing airs, becauſe a ſufficient and a better regulated heat is produced without one; a flat plate, however, is uſeful to cover the furnace when the operation is over, which when the door of the aſh-pit and the air-hole are ſhut, will ſoon extinguiſh the fire.

Dimensions of the Apparatus. The apparatus is made of *two ſizes*. The hydraulic bellows of the *larger*, is 12 inches diameter, and the moveable veſſel J riſes about 15 inches, ſo that each inch in height contains 113 cubic inches, and the whole bellows 1695 cubic inches, or rather leſs than a cubic foot. The bellows of the *ſmaller* apparatus are about one third of the contents of the larger, being $8\frac{1}{2}$ inches diameter, and riſing 10 inches, ſo that each inch in height contains 57 cubic inches, and

and the whole bellows conſequently 570, or about one third of a cubic foot.

The Air-holders are alſo made of two ſizes, the larger containing a cubic foot, and the ſmaller half a cubic foot; which dimenſions have been fixed upon as convenient for carriage when filled with air, and capable of being lifted by one perſon when full of water, which would not be the caſe if the contents were more than a cubic foot.—The ſmall air-holders will, on account of their reduced contents, be chiefly uſeful for conveying *Fixed air*, which ſhould be ſent out in ſuch quantities only as are likely to be uſed at once. For if water be poured into an air-holder to expel part of the fixed air, and the air-holder be afterwards corked up and laid bye, great part of the remaining air will be abſorbed by the water.

The large Fire-tubes are three inches in diameter within, and have 14 inches in length expoſed to the action of the fire; the Alembic, when filled to the neck or cylindrical part, is about equal to them in its contents. The ſmall fire-tubes are $2\frac{1}{4}$ inches diameter within, and have 9 inches expoſed to the action of the fire, conſequently the contents of the larger tubes is to that of the ſmaller as 126 to 45, but the quantities of air which will be produced

from them reſpectively, will not follow that ratio, becauſe the heat will be more readily communicated to the centre of the matter contained in the ſmall tubes, than it will to that of the large ones. Their reſpective actual performances have not been compared.

The larger apparatus is particularly uſeful where conſiderable quantities of air are required, eſpecially for carbonic acid air from chalk or marble, or oxygene air from manganeſe, where it is of ſome conſequence to be able to operate upon a large quantity of materials at once.

For the uſe of private individuals, or for experiments, the ſmaller apparatus will be found large enough; but if any quantity of air is wanted to be produced, and the operator is not too much confined for room, it will be adviſeable to combine the larger bellows and refrigeratory with the ſmaller furnace, to avoid the trouble of too frequently emptying the bellows, and to enable the operator to retain a reſerve of air within them.

Stools. Before attempting to uſe the apparatus, ſtools ſhould be provided for the different parts to ſtand upon. They are beſt made with round tops, and for the *large apparatus* ſhould be 16 inches

inches diameter, and about 1½ inch thick, of elm or oak board, with three plain feet.—The following heights are taken from the ſtools to the ground:

Stool for the Refrigeratory -	18 inches.
Ditto Hydraulic bellows -	24
Ditto Air-holder, allowing an inch for the thickneſs of the tub it ſtands in - - - - -	8½

When the fire-tubes are uſed, the ſame ſtools as above will ſerve, only an additional one of 14½ inches high, muſt be provided to place the furnace upon. This may be made of iron, but the heat is not there ſufficient to burn it, even if of wood.

The *ſmall apparatus* is adapted ſolely to the uſe of fire-tubes, and the following ſtools of one foot diameter will be neceſſary in uſing it:

Stool for the Furnace to ſtand upon	12 inches high.
Ditto for Refrigeratory - -	17 ditto
Ditto for Hydraulic bellows -	23 ditto
Ditto for *large* Air-holder (allowing one inch for the thickneſs of the tub) - - - - -	7 ditto

Theſe ſtools are required to be ſo high on account of the air-holder, which would not otherwiſe

have room to empty its water into a moderate ſized tub. The elevation of the apparatus will be found a convenience to the operator.

If the ſmaller furnace be adapted to the larger apparatus, the heights of the ſtools will be as above, excepting that of the refrigeratory, which muſt be reduced to 16 inches; but in that caſe the ſtools of courſe muſt be of the diameter mentioned for the larger apparatus.

A ſtool that can be raiſed and depreſſed at pleaſure, will be found convenient for placing the apparatus upon that is intended to receive air under water. See page 5.

GENERAL DIRECTIONS

FOR

The Uſe of the Apparatus.

AS it has been already mentioned that the fire-tubes are more convenient for general purpoſes than the alembics, it may be proper to deſcribe their uſe firſt.

FIRE TUBES. Thruſt the plug ſent with the apparatus into one end of the tube, and holding it perpendicularly reſting upon that end, put into it what quantity you pleaſe of the material to be acted upon, taking care that the whole lie within the wide part. Lay the tube upon its ſide, take out the plug, anoint the end piece, which correſponds to the conducting-pipe, with the *Fire-lute* hereafter deſcribed, and (having firſt put one of the caſt iron rings upon that end of the tube) inſert it into the tube, turn it round a little, preſſing in at the ſame time, and then give it a gentle blow with

a piece of wood, to force out the ſuperfluous lute. Paſs the fire-tube through the two holes made in the furnace to receive it, and put the remaining iron ring upon the other end of it, ſo as to fill the hole on that ſide. Anoint the conical end of the conducting-pipe with lute, and thruſt it into the end piece above-mentioned, letting it incline about an inch towards the refrigeratory, into the receiving-pipe N of which the other end muſt be inſerted, being previouſly anointed with the *Cold Lute* hereafter deſcribed. Join the pipe O of the refrigeratory with the communicating pipe P of the hydraulic bellows, uſing the above lute for the joints. Theſe being adjuſted, anoint the other end piece of the fire-tube with fire-lute, and fix it in its place, ſo that the water-pipe C D may be perpendicular. Lute alſo the joint of the water-pipe, and fix it in its place. Fill the cup D with water, having firſt ſcrewed down the wire E, that no water can paſs into the fire-tube.

As water is not abſolutely eſſential for the production of oxygene from manganeſe, you may in that proceſs inſert the iron plug, properly anointed with fire-lute, into the tube, in lieu of the end piece above-mentioned.

You may now proceed to light the fire*.—Lay the lead weights upon the inner veſſel of the refrigeratory, and fill it with water, as alſo the outer veſſel of the hydraulic bellows up to the dotted line ſhewn in *plate* 2, *fig.* 1, but no higher, otherwiſe the water will run down the perpendicular pipe V. Preſs down the inner veſſel J of the bellows to empty it of air, cork the diſcharging-pipe Q, and hang on the balance weight L†.

As ſoon as the lute of the joints which are expoſed to the action of the fire is dry and hot, apply to them ſome of the *Fat-lute* hereafter deſcribed, and to prevent its running off, ſtrew ſome dry ſlaked lime over them. This fat-lute will prevent the joints from cracking, but care muſt be taken that none of it get into the inſide of the fire-tube, as it would give a bad ſmell to the air.

In caſes where water is neceſſary for the production of the factitious air, as ſoon as the fire-tube is become red hot, unſcrew the wire E, ſo as

* The directions here given are for the *Circulating* Refrigeratory, as being moſt commonly uſed; thoſe for the *Cloſe* Refrigeratory will be found under the article Fixed Air; and thoſe for the *Pipe* Refrigeratory under Phlogiſticated Air.

† The Air-holder may either be fixed on now, or hereafter, as deſcribed page 25.

to admit a little water into it. The air will immediately paſs through the conducting-pipe to the refrigeratory, and gliding along its ſpiral in contact with the water, will arrive at the bellows through the pipe P, waſhed and cooled. It is beſt to admit no more water into the fire-tube than enters into the compoſition of the airs, or is neceſſary for their expulſion, as you will thus obtain them apparently more condenſed and powerful, than when a ſuperfluous quantity of water is admitted. The latter circumſtance may be known by the pipe at N becoming too hot for the finger to bear.

Care ſhould be taken to renew the water from time to time in the refrigeratory, and to keep the agitator conſtantly in a gentle motion if the production of the air is quick, but in caſes where the production of air is not very rapid, it will be ſufficiently waſhed and cooled without uſing the agitator. In proceſſes where you wiſh the fixed air to be abſorbed that may accompany the other factitious airs, it will be found neceſſary to fill the refrigeratory with lime water, or ſtill better, to add powdered quicklime to the water contained in it. The inner veſſel J of the hydraulic bellows will riſe gradually as the factitious air enters, but when it is full, or nearly ſo, it is proper to transfer the air into the air-holder, which for that purpoſe muſt be placed

placed upon a ſmall ſtool in a ſhallow tub, and filled with water through the central pipe, in the manner already directed. Connect the air-holder to the bellows by means of the transfer-pipe *g*, and lute the joints. Then take out the cork from the lower pipe Z, and the counterpoiſe of the bellows being lifted up, the factitious air will paſs into the air-holder, and the water be emptied into the tub. The iſſuing of the water may be rendered ſlower at pleaſure, by holding the end of the cork againſt the opening of Z, which ſhould be re-corked as ſoon as the air-holder is full, or the bellows compleatly emptied of air. The air-holder is then to be removed, and all the pipes to be well corked.

It ſhould be kept in a cool place until the air is wanted, which may be transferred into one of the oiled bags, as follows:—Fix the faucet, or mouth piece of the bag, lapped round with ſome wet linen rag, tied with a thread, into the inner pipe U of the air-holder, having previouſly ſqueezed out all the common air out of the bag, in the manner directed page 14. If you want a quart, gallon, or other meaſure of factitious air, pour that quantity of water into the air-holder, by means of the funnel *k*, through the central pipe (which reaching within half an inch of the bottom, precludes

cludes the air from eſcaping) and exactly that meaſure of the incloſed air will iſſue out into the bag*. Then recork your air-holder, if not exhauſted of air, apply at the ſame time your thumb on the outſide of the bag, and preſſing it againſt the inner orifice of the faucet, to prevent the exit of the air until you can inſert the ſpiggot, which ſhould be previouſly wetted.

The quantity of atmoſpheric air wanted to be mixed with the factitious air, ſhould be thrown into theſe bags by a pair of common bellows, the nozzle of which will admit the faucet of the bag, or by an hydraulic bellows appropriated to that purpoſe, and not by that which receives and meaſures the factitious airs, which will in general be otherwiſe employed. The ſmaller ſized bellows will be found ſufficiently large for this purpoſe. When both the airs are included in the bag, it ſhould be repeatedly turned up and down, in order that they may be perfectly mixed.

* It has been already remarked, that the factitious air may be transferred immediately from the hydraulic bellows into the bags, by inſerting the faucet, lapped round with a linen rag, into the diſcharging pipe Q, and ſuffering the inner veſſel of the bellows to deſcend, until as much air as is required enters the bag, which you may know by marking the quantity of the deſcent of the bellows.

Some

Some gentlemen prefer an hydraulic bellows made to hold three or four cubic feet of air, to the bags for breathing out of; but ſuch an apparatus cannot fail of being cumberſome in many caſes, and in all will be troubleſome to remove, eſpecially when filled with air.

Should the factitious air contained in the air-holder, require to be more thoroughly freed from fixed air or acid fumes, than has been done before; it may be effected by putting ſome dry ſlaked lime down the central pipe, pouring a ſmall quantity of water upon it, and agitating the veſſel briſkly; but ſo much atmoſpheric air will enter on uncorking the pipe as there was fixed air abſorbed.

Air Magazine. Some perſons may wiſh to preſerve in readineſs larger quantities of air than can conveniently be kept in air-holders. The moſt readily conſtructed veſſel to anſwer this purpoſe, would be a common caſk or hogſhead, open below, and ſuſpended over another larger caſk, filled with water, by a cord going over pullies, and a counterpoiſe, in the ſame manner as the hydraulic bellows. The air might be admitted and taken out by means of a flexible pipe and a cock attached to and communicating with the upper end of the ſuſpended

ſuſpended caſk; the latter veſſel being rendered air-tight, by ſhaving it ſmooth both inſide and out, and filling up its pores with bees wax, applied when the caſk has been made very hot by a fire of ſtraw or ſhavings. The wax ſhould continue to be applied until the pores will receive no more, and then the ſuperfluity be wiped off. Oiled paint would give a poiſonous impregnation to the water, and a mixture of roſin gives a bad ſmell.

For inflammable and dephlogiſticated airs, the water over which they are kept may be impregnated with lime, which will prevent the putrefaction of the water, and will alſo ſerve to abſorb the fixed air. Fixed air itſelf cannot long be preſerved in this way, even when there is no lime in the water. Something of the ſame nature with the air-holder, ſeems moſt proper for this air, as the ſmall quantity of water included with the air, would ſoon be ſaturated; and for the ſame reaſon, the air-holder applied to this uſe, ſhould not be large, otherwiſe the water employed to expel part of the air, might abſorb the remainder.

ALEMBIC, or FIRE-POT. When you have put into this veſſel the proper quantity of materials to produce the factitious air, force a piece of iron down through them to make way for the water-pipe,

pipe, then lute the joint of the capital B, and fix it in its place. Lute and put in the lower part of the water-pipe C; ſet the pot on its pedeſtal in the middle of the furnace, and connect together the remaining parts of the apparatus, as has been deſcribed when the fire-tubes are uſed.

In letting in the water and regulating the whole of the apparatus, proceed exactly in the manner related above.

LUTES, or CEMENTS. *Fire-lute.* To join together the joints expoſed to the action of the fire, viz. the end pieces and water-pipe with the fire-tube, the capital with the alembic and the conducting-pipe to either of them, the proper lute is the Corniſh porcelaine clay, or ſlaked and finely ſifted lime, mixed to the thickneſs of paint, with a ſolution of two ounces of borax in a pint of hot water.

Cold lute. For the other joints, a paſte of dough made of about equal parts of wheat flour and porcelaine clay, or common whiting, which, for greater ſecurity, may when the joint is luted, be wrapped round with a rag. A ſlip of oiled ſilk does very well without any lute.

Fat lute. Is made of finely ſifted ſlaked lime and

and drying linſeed oil, wrought into a pretty ſtiff paſte, and applied to the hot joints with a ſmall trowel.

Fuel. The proper fuel is good coaks or cinders of pit coal, which ought not to be of the heavy ſort, nor too ſmall, as in either caſe you would have a dull fire. The charcoal of wood would anſwer very well, but it is expenſive, and the conſumption would be conſiderable. A fire of pit-coal not coaked, is irregular and unmanageable. Care muſt be taken to have your coaks well dried ; and the firſt time you uſe the furnace, you will do well before you operate, to warm and dry it with a fire of coaks, to chaſe off any moiſture the bricks may have imbibed, otherwiſe your fire will be long in lighting.

General

General Cautions.

EACH time before you uſe the apparatus, it ſhould be waſhed with cold water, to free it from any effluvia it may retain from the laſt operation. The ſame fire-tube or pot ought not to be uſed for producing different airs; and for this reaſon, it will be proper to keep one appropriated to the making of each. Indeed, ſhould ever an eſtabliſhment be formed for making large quantities of the different kinds of air, it will be certainly adviſeable to have an entire apparatus appropriated to the making of each kind.

No bituminous or oily ſubſtances ſhould be put into the pots or tubes, for the making of inflammable airs, or any other purpoſe. Nor ſhould any ſubſtance likely to yield any of the mineral acids, be uſed in the apparatus, as the fumes would deſtroy both the conducting-pipe and the refrigeratory. The ſame objections lie againſt the volatile alkali, and to putting any alkali into the water of the refrigeratory; but as far as has been obſerved, lime-water does not hurt the varniſh.

The

The proceſs for obtaining the inflammable airs, ſhould not be conducted by candle light, otherwiſe the approach of the candle to the ſtream of air may occaſion dangerous exploſions. For the ſame reaſon, when any patient is inhaling this air by candle light, the candle ſhould be kept as diſtant as poſſible.

In all caſes, wherein the powdery matter which the air brings over in the form of ſmoke, is not intended to be taken into the lungs, the air ſhould be kept twelve hours at leaſt before it is uſed, that it may make its depoſit.

DIRECTIONS

DIRECTIONS

FOR

Procuring the Airs.

THE directions here given, are not intended to comprize all the methods of procuring each air, but merely thoſe which have been found the cheapeſt and moſt eaſily practiſed. For the hiſtory of Factitious Airs, their chemical qualities, and the means of judging of their purity, the reader is referred to the laſt edition of *Dr. Prieſtley's Experiments, in 3 vols 8vo.* to *Lavoiſier's Elements of Chemiſtry*, and for a conciſe general view of the ſubject, to *Nicholſon's firſt principles of Chemiſtry.*

I. DEPHLOGISTICATED, or OXYGENE AIR. This air is beſt obtained from manganeſe, by mere heat. The methods of obtaining it from nitre, from ſpirit of nitre, or from manganeſe, by means of vitriolic acid, are objectionable, becauſe ſome acid always accompanies it in theſe caſes, from which the air is difficultly freed, and this apparatus would ſuffer from corroſion, unleſs very trouble-

ſome means were employed to purify the air before it arrived at the refrigeratory.

Manganeſe, for this purpoſe, ſhould be free from calcareous earth and noxious minerals. A very good kind is found near Exeter, which ſeems to poſſeſs theſe requiſites. The preſence of calcareous earth may at any time be detected, by pouring diluted nitrous acid upon the powdered manganeſe, for if it contain any, there will be a continued effervescence, which otherwiſe would not take place.

The manganeſe to be put into the fire-tube or pot, muſt be reduced to a coarſe powder, all the joints muſt be properly prepared, and every part of the apparatus fixed in its place, as has been directed; the opening for the water-pipe is to be ſtopped with an iron plug, or with the water-pipe itſelf, having ſcrewed down the wire ſo as to admit no water; but ſome water may be put into the cup by way of precaution, merely to prevent the eſcape of air, if the conical wire ſhould not be tight. The fire is then to be lighted, and ſuffered to burn gently until the air begins to come, when it may be gradually augmented until the air ceaſes to be produced.

Water

Water is not abſolutely neceſſary in this proceſs, for although it ſeems rather to accelerate the production of the air, it does not augment the quantity produced. It is therefore as well to make uſe of the iron plug to ſtop up one end of the fire-tube, inſtead of the end-piece and water-pipe as above directed.

A pound of the hard part of *Exeter* manganeſe, yields about 1400 cubic inches of air, highly dephlogiſticated, and a very ſmall portion of fixed air, which will be abſorbed by the water in the refrigeratory. The ſoft or clayey part ſeems not to yield ſo much, but what it does yield is equally pure.

Some manganeſe yields its air at ſo low a heat, that it is neceſſary to have every joint tight, and all the apparatus ready before the fire is lighted. If the manganeſe happen to be wet, it will be a conſiderable time before any air comes over.

The fire-tube of the large furnace holds about 6 lb. of manganeſe, which will yield about five cubic feet of air; thoſe of the ſmall furnace contain nearly 3 lb. and yield about two and a half cubic feet of air.

Mendip manganeſe contains much calcareous earth, and conſequently yields fixed air combined with phlogiſticated or azotic air, both in the beginning and end of the proceſs. A pound yields only about 500 or 600 cubic inches of impure dephlogiſticated air, of which about one third part is abſorbed by waſhing it with lime and water. To aſcertain the point at which it begins to yield dephlogiſticated air, take out the plug in the conducting-pipe, from time to time, and hold a lighted candle near the hole; from the brightneſs of the flame you will eaſily diſcover when the oxygene begins to come and when it ceaſes, and thus you may be able to keep it ſeparate from the other airs.

Objections have been ſtarted againſt the air from manganeſe, the ſalubrity of which it is ſaid has not been conſtituted by experiment, and even if it ſhould be found innocent when taken into the ſtomach, that as an earthy powder it may have bad effects upon the lungs. To this it is anſwered, that if the air ſtand a few hours, it will depoſit the merely ſuſpended earth, and what it retains will be in a ſtate of ſolution in the air, and of too fine a texture to prove hurtful, as ſoft powders are found not to injure that organ. It is farther anſwered, that Dr. Beddoes and others have conſtantly given the

air from manganeſe, without perceiving any bad effects attributable to that cauſe; and laſtly, that no other means of obtaining this air equally unexceptionable, have yet been pointed out. For it ſeems undeniable, that the fumes of nitrous acid, or of the ſulphuric, muſt prove much more deleterious than the powder of manganeſe, and they ſeem almoſt *inſeparable* from the airs obtained from nitrous and vitriolic ſalts.

II. Phlogisticated, Azotic, or Nitrogene Air. No proceſs for producing this air unmixed with other airs, by means of mere heat, has yet been diſcovered, but it may be readily enough obtained mixed with fixed air.

Plate 3, *fig.* 5, repreſents a chafing diſh, nine inches high and ſix inches diameter, communicating through the medium of the pipe refrigeratory *n m*, with an hydraulic bellows at *n*. The chafing diſh is to be compleatly filled, or rather heaped, with the charcoal of ſome of the ſofter woods, and in preference of that of the twigs or ſmall branches, previouſly kindled and made red hot in a common chafing diſh. The trough of the refrigeratory is to be filled with cold water, and the end *n* to be connected with the pipe P of the hydraulic bellows. Theſe muſt be ſuffered to riſe very ſlowly, ſay thoſe

of the larger apparatus in five or ſix minutes. The air which has ſerved to animate the fire, and has there been deprived of its oxygene, will paſs through the ſide pipe of the chafing diſh and the pipe of the refrigeratory into the bellows; and when the operation has been properly performed, it will be found to contain no uncombined oxygene air.

If the uſe to which this air is to be applied, requires it to be freed from the fixed air it contains, that may eaſily be effected, by agitating it in the air-holder with a mixture of lime and water, or with a ſufficient quantity of pure water.

III. Fixed, or Carbonic Acid Air. Take as much good chalk as your fire-tube or pot will hold, break it into bits of about a quarter of an inch cube, and ſoak or boil it in a large quantity of water, to extract any ſaline matter it may contain. Put it into the fire-tube or pot, and prepare your apparatus, as has been already directed, making uſe of the cloſe refrigeratory, as repreſented in *plate* 3, *fig.* 1; unleſs, for particular purpoſes, you wiſh to have your air waſhed, and do not value the loſs of a ſmall quantity; in which caſe you may make uſe of the circulating refrigeratory, as has been ſaid before.

When

When your fire has burnt up, and your fire-tube or pot is become fully red-hot, admit water ſlowly by the water-pipe, and the fixed air will immediately iſſue and paſs to the bellows.

If you make uſe of the cloſe refrigeratory, you muſt renew the cold water in the upper part from time to time, that the air below the diaphragm may be properly cooled, and any ſteam it brings over with it may be condenſed.

Chalk is recommended in preference to marble, as it gives out its air at a lower heat.

The fire-tube of the ſmaller apparatus, when filled full, which it always ſhould be, as otherwiſe the ſteam may paſs over without acting upon it, will hold about $1\frac{1}{2}$ lb. of chalk, which will yield about four cubic feet of very ſtrong fixed air, mixed with ſome inflammable air from the iron tube.

The fixed air thus obtained, carries with it ſome of the chalk in a ſtate of ſuſpenſion, which it will depoſit by ſtanding a few hours in the air-holder, or other convenient veſſel.

IV. Inflammable, or Hydrogene Airs. Firſt, *Zincic Inflammable Air*. The pureſt, or at leaſt

leaſt the lighteſt ſpecies of this air, is produced from zinc. The metal being broken or granulated, a few pounds of it is to be put into the alembic, and the apparatus being adjuſted with the circulating-refrigeratory, &c. as before directed, it is to be brought to a ſtrong red heat, and water to be admitted very ſlowly. It ſeems impoſſible to avoid the circumſtance of a conſiderable quantity of ſteam accompanying the air, which renders it neceſſary to renew frequently the water in the refrigeratory.

This air carries with it a large quantity of the flowers of zinc in ſuſpenſion, which it depoſits by ſtanding at reſt; it probably alſo contains another quantity in a ſtate of ſolution, which ſeems to form a part of its ſubſtance, and on which ſome of its virtues may depend.

If the air is wanted to be ſtill more highly charged with the flowers of zinc, it would be proper to make uſe of the cloſe refrigeratory.

When the fire-tubes are uſed in this proceſs, part of the zinc ſublimes in a metallic ſtate, and is apt to choak the end pieces; the alembic is therefore recommended in preference, as being free from that inconvenience. Only a ſmall quantity ſhould be put in at a time, as the water could not force its way through any depth of the melted metal.

As

As zinc does not produce very large quantities of inflammable air, and is more expenſive than iron, Dr. Beddoes adviſes to put in only a few ounces of zinc, and to fill up the fire-tube with hammered iron turnings. The air produced in this way will probably carry with it both iron and zinc.

2. *Martial Inflammable Air*, or Hydrogene Gas from Iron, is the next in ſpecific gravity to the inflammable air from zinc, and like it carries with it ſome of the metal from which it is formed. It has alſo more of an hepatic ſmell than the zincic air.

To produce it, the fire-tube or pot is to be filled with the turnings or chippings of hammered iron, which may be had from the whiteſmiths'. Caſt iron turnings or borings give much more of the hepatic ſmell, and alſo contain more charcoal or carbone. Before the turnings are put into the fire-tube or pot, they ſhould be heated red hot in a crucible, and quenched in water, to free them from oil, or other combuſtibles.

The apparatus is then to be adjuſted as in the former caſes; and when the fire-tube or pot is red hot, water is to be gradually admitted, which will readily extricate the air.

The

The fire-tubes of the ſmall apparatus hold about two pounds of hammered iron turnings, which yield a large quantity of air.

When the turnings uſed for this purpoſe have not been exhauſted, if they are plunged red hot into water, they will throw off the ſcale or calcined iron, and when heated again, will preſent freſh ſurfaces, to the action of the water.

3. *Heavy Inflammable Air, Carbonated Hydrogene,* or *Hydro Carbonate.* Take charcoal made of the twigs of the ſofter woods, ſuch as willow, poplar, hazle, birch, or ſycamore, avoiding ſuch as have reſinous or aſtringent juices. Prepare the charcoal by heating it to full ignition in an open fire, and quenching it in clean water; or by filling a crucible with it, covering it with clean ſand, and expoſing it to a ſtrong heat in an air furnace, and then ſuffering it to cool. In either of theſe caſes it will be found free from any bituminous matter, which might contaminate the air, as generally happens with common charcoal.

The fire-tube or pot is to be heated red hot, and water admitted, as directed in the other caſes. It has been obſerved by Dr. Prieſtley, and confirmed by my experience, that where much water paſſes

paſſes in the form of ſteam, there is alſo much fixed air formed; but leſs, or none, when the water is admitted ſo ſparingly that no ſteam reaches the refrigeratory; and in the latter caſe it ſeemed to me that the air was more potent, that is, it was more ſubject to cauſe vertigo, &c.

This air having generally a diſagreeable ſmell, an experiment was made with a view of producing it more free from that quality. Half an ounce of charcoal, finely powdered, was intimately mixed with half a pound of ſlaked, but cauſtic lime, quite dry. This mixture was put into the fire-tube, and without the addition of water, produced about a cubic foot of inflammable air, with much leſs ſmell than uſual, and in the opinion of my operator not ſo likely to cauſe vertigo.

The production of the carbonic inflammable air by the addition of water is very rapid, as even the ſmall fire-tubes will produce a cubic foot in five or ſix minutes. With the lime the production is ſlow.

4. *Animal Inflammable Air* is produced by putting any animal ſubſtance into the fire-tube or pot, and expelling the air by mere heat; wool, hair, and feathers, produce it in larger quantities than the

the muſcular part of animals. In all caſes the air thus obtained is extremely fœtid and deleterious, cauſing vertigo and permanent nauſea. It brings over large quantities of volatile alkali, which hurts or deſtroys the varniſh of the appartus. If it ſhould be thought that it would prove uſeful in any diſeaſes, it is probable that the air obtained from the charcoal of animal ſubſtances may be as ſalutary, and leſs nauſeous, than that obtained from them in their freſh ſtate. It is therefore propoſed to reduce wool, feathers, or hair to charcoal, in a cloſe veſſel expoſed to a ſtrong heat; to put this charcoal into the fire-tube, and to obtain the air by the addition of water; by which proceſs it is thought it will be obtained more free from the fœtor, and from the volatile alkali.

Miſcellaneous Obſervations.

IN every operation in which water is requiſite to the production of the airs, the fire-tube ſhould be filled compleatly with the bruiſed material, otherwiſe the ſteam would paſs over the ſubſtance without acting upon it. This precaution alſo renders the production of the air more rapid and certain, and at the ſame time leſſens the proportionate produce of inflammable air from the fire-tube, which, eſpecially with a new tube, might otherwiſe form a conſiderable part of the whole.

A *Coating* for the inſide of the fire-tubes, which would prevent the action of the ſteam, or other ſubſtances on the tube, is deſirable, but none which compleatly anſwer that purpoſe have hitherto occurred. The beſt has been the lute of China clay and ſolution of borax. To apply this, the tube ſhould be made as warm as the hands can bear, and one end being ſtopped up by the plug, the lute ready mixed up to the conſiſtency of cream, is to be poured into the tube. The other opening is then to be ſtopped, the tube agitated in all directions

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tions for a ſhort time, and the lute, which does not adhere, ſuddenly poured out; after which, the tube muſt be rolled upon a table until the heat has evaporated the water of the lute. It is probable that this lute might be improved by an addition of calcined flints ground to fine powder, ſuch as are uſed in the Staffordſhire potteries.

When inflammable air is prepared by means of zinc, the pot ſhould be coated in this manner, to prevent the zinc, or its calx, from adhering to the iron, which it would otherwiſe do, and be difficultly got off.

Earthen-tubes or *pots*, which would be air-tight, and would ſtand repeated heating and cooling, would be a valuable acquiſition; but conſidering every circumſtance, this ſeems hardly practicable, as the crucible compoſitions which are beſt adapted to bear the heating and cooling, are too porous to contain the airs, and generally too tender to bear the fitting in of the end-pieces.

From ſome circumſtances it appeared probable, that the matter which communicated ſmell to the inflammable airs, might alſo be the cauſe of vertigo, and other diſagreeable effects, it was therefore attempted to deprive them of ſmell. A quart bottle was filled with ſome very ill-ſcented hydro carbonate,

nate, and an eight ounce vial, with a mixture of calcined charcoal-duſt and water. The mouths of the two were luted together with a ſtrip of bladder, and inverted; the contents of the vial fell down into the bottle, where it was well agitated with the air, the apparatus was then reverſed, and the operation repeated more than once. On opening the bottle, it was found that the air had loſt its *bad* ſmell; its odour was not entirely gone, although what it retained was not unpleaſant. However I ſoon found, by merely ſmelling at the mouth of the bottle, that it had not loſt its power of cauſing vertigo. Conceiving theſe ſmells to be cauſed by ſulphur in ſome of its forms, it was thought that *a metallic calx* might produce the ſame effects. The powder of calcined manganeſe was ſubſtituted for the charcoal in another experiment, and apparently produced a ſtill more powerful effect. The proceſs with charcoal was attempted upon a larger quantity of air in the air-holder, but it was found that it required conſiderable quantities of charcoal-duſt and of water, to produce the effect even in an imperfect manner. The experiment, however, ſeems worthy of repetition, as the ſmell with people of delicate nerves, will always be ſome obſtacle to the free uſe of the airs.

In the mean time, it is recommended to try the following method in the extrication of inflammable

mable air from charcoal and from iron. When you charge the tube, fill it half or three quarters full with clean waſhed and calcined ſand, the kind called *Calais ſand* ſeems the moſt proper, and upon this put the charcoal or iron to be operated upon, which will thus lie next to the water-pipe. The air produced muſt paſs through the interſtices of the red-hot ſand before it can arrive at the refrigeratory, and it is expected will be conſiderably changed by thus coming into contact with ſo much hot ſurface. The experiment may be varied, by ſubſtituting cauſtic ſlaked lime, or clean pounded tobacco pipes, in lieu of the ſand*.

If the fire-tube is entirely filled with ſand, and the vapour of ſpirits of wine, or of ether, from a ſmall retort, are made to paſs through it, inflammable airs will be produced of the nature of hydro carbonate, though ſpecifically ſomewhat different.

* Whether the Hydro Carbonate thus obtained in a purer or more inflammable ſtate, would have the ſame virtues as a medicine, muſt be left to Phyſicians to determine; I fear it would not, as it would approach near to the nature of the metallic inflammable airs, which are not ſo powerful.

Reference to the Plates.

PLATE I. *Fig.* 1. Elevation of the Large Pneumatic Apparatus, with the Alembic. *Fig.* 2, Bird's Eye View of the Furnace, with its Covers. *Fig.* 3, Section of the Fire-tube and Furnace, according to the firſt Conſtruction.

PLATE II. *Fig.* 1. Sections of the inner and outer Veſſels of the Hydraulic Bellows. *Fig.* 2, Section of the outer veſſel of the Circulating Refrigeratory. *Fig.* 3, Section and Plan of the inner Veſſel of the Circulating Refrigeratory. *Fig.* 4, Section of the Alembic and Water-pipe. *Fig.* 5, Section of the upper Part of the Water-pipe, and View of the Conical Wire.

PLATE III. *Fig.* 1. Elevation of the Large Pneumatic Apparatus, with the improved Furnace Fire-tube, Cloſe Refrigeratory, and Air-holder. *Fig.* 2, Plan of ditto. *Fig.* 3, Section of the Furnace and Fire-tube. *Fig.* 4, Section of the Small Furnace, with Sand Bath, Retort, and Chimney adapted for Diſtilling. *Fig.* 5, Section of the Pipe Refrigeratory.